Title: Lines, Angles, Polygons - Putting Them All Together

Brief Overview:

> Students will create models of lines segments, rays, angles, and polygons using a variety of materials. In this unit students will identify attributes of geometric shapes and use tools to measure and classify angles. Students will use their problem solving skills to combine a variety of geometric shapes to completely cover a rectangular surface.

Links to NCTM 2000 Standards:

- **Standard 3: Geometry and Spatial Sense**
  Mathematics instructional programs should include attention to geometry and spatial sense so that all students analyze characteristics and properties of two-dimensional geometric objects; and use visualization and spatial reasoning to solve problems both within and outside of mathematics.

- **Standard 4: Measurement**
  Mathematics instructional programs should include attention to measurement so that all students apply a variety of techniques, tools, and formulas for determining measurements.

- **Standard 6: Problem Solving,**
  Mathematics instructional programs should focus on solving problems as part of understanding mathematics so that all students build new mathematical knowledge through their work with problems; and develop a disposition to formulate, represent, abstract, and generalize in situations within and outside mathematics.

- **Standard 7: Reasoning and Proof**
  Mathematics instructional programs should focus on learning to reason and construct proofs as part of understanding mathematics so that all students select and use various types of reasoning and methods of proof as appropriate.

- **Standard 8: Communication**
  Mathematics instructional programs should use communication to foster an understanding of mathematics so that all students organize and consolidate their mathematical thinking to communicate with others; express mathematical ideas coherently and clearly to peers, teachers, and others; and use the language of mathematics as a precise means of mathematical expression.

- **Standard 9: Connections**
  Mathematics instructional programs should emphasize connections to foster an understanding of mathematics so that all students understand how mathematical ideas build on one another to produce a coherent whole; and recognize, use, and learn about mathematics in contexts outside of mathematics.

- **Standard 10: Representation**
  Mathematics instructional programs should emphasize mathematical representations to foster an understanding of mathematics so that all students use representations to model and interpret physical and mathematical phenomena.

Grade/Level:

Grades 4-5

Duration/Length:

2 - 3 classroom sessions

Prerequisite Knowledge:

Students should have working knowledge of the following skills:

- Working cooperatively
- Using basic mathematical operations
- Using centimeter rulers, protractors, Polaroid camera
- Creating a collage/poster
- Creating patterned designs
- Using the symbols for less than and greater than appropriately
- Estimating
- Meanings of: point, straight path, parallel, plane

Student Outcomes:

Students will:

- work cooperatively in groups of four.
- create, identify attributes, measure, and label line segments and angles.
- create, identify attributes, distinguish, and label polygons.
- investigate the relationship between the number of sides and angles of polygons.
- create a labeled collage/poster of geometric shapes represented by objects and/or snapshots gathered from the nature walk.
- create a geometric design from a given set of polygons.

Materials/Resources/Printed Materials:

Supplies:
- Sticky dots
- Pre-cut paper arrows
- Yarn – 3 foot lengths, one for each group of four students

- Poster board
- Scissors
- Tape/Glue
- Construction paper (various colors)
- Measurement tools – centimeter rulers, protractors
- Coffee stirrers, pipe cleaners, toothpicks
- Writing Utensils – pencils, markers, colored pencils etc.
- Containers for objects gathered during nature walk, one for each student group
- Transparencies of Student Resource Sheet 2
- Clipboards (for recording data during nature walk, one for each student group)
- Student Resource Sheets 1-7

Equipment:
- Polaroid or digital camera and appropriate film/recording media
- Overhead projector

Teacher Preparation:
- Prepare a large poster board chart similar to Student Resource Sheet 1 to be hung at front of the room
- Prepare a set of index cards with the following words. Prepare a complete set for each student group.
  ENDPOINT – 2 cards
  VERTEX – 3 cards
  RAY – 2 cards
- Prepare a set of pre-cut arrow heads - 2 for each group

Development/Procedures:

Day 1
- Access students' prior knowledge of a point and straight path by using students as models for demonstration. (Teacher Resource 1)
- Have two students (Student 1 and Student 2) from each group stand opposite each other at a distance of approximately 3 feet. Students will model a line segment by holding a piece of yarn at each end. The first group to complete the model will demonstrate the results for the class.
- Through discussion have students describe a line segment. Elicit the response that a line segment is a straight path with two endpoints. (Students represent the endpoints. Yarn pulled taut is the straight path.) Give each student a letter for identification (i.e., Student 1 = A, Student 2 = B).

Teacher Note:
When 'Refer to new word list chart' is referenced in these procedures, update the "New Word" list chart that was created on big poster board paper with the definition and graphic representation of the geometric shape. At the same time Student 4 from each group should be updating Student Resource Sheet 1 for his/her group.

- Have a third student (Student 3) from each group join the two students from their group modeling a line segment. Student 3 will add another point to the line segment AB approximately in the center by holding onto the yarn.
- Ask students how many line segments are now being modeled? Give Student 3 a letter for identification (ex. Student 3 = C). Elicit response that there are now two line segments identified as AC and CB. Introduce that Student 3, who is Point C, represents an **interior point** of the line segment. (Refer to new word list chart)
- Have Student 3 extend or stretch the yarn outward at point C to form an angle. Question students as to what they would call the new geometric shape eliciting the word **angle** as a response. Introduce that Student 3 now has the name of **vertex**. Refer to the New Word list chart).

Teacher Note:
At this point Students 1 and 2, representing endpoints A and B, need to transition to arrows instead of endpoints so that the line segments now become **rays**. This can be accomplished by having Students 1 and 2 hold the yarn approximately 1 inch from the end and place an arrow at the ends of the yarn.

- Have students develop a definition of an **angle**. (An angle is defined as two rays that meet at a vertex. (Refer to the New Word list chart).
- Provide Students 1, 2, and 3 with instructions to transition from an angle to a triangle. (Teacher Resource 2). Announce that Students 1 & 2 have now been renamed to vertex (plural vertices) -- the same name as Student 3.
- Discuss with students the transformation from an angle to a **triangle**. Have students discuss the attributes of a triangle leading them to develop a definition of a triangle. (The attributes of a triangle include: It has 3 sides/line segments, 3 angles, and 3 vertices.) (Refer to the New Word list chart).

Teacher Note:
At this point Students 1, 2, and 3 return to their seats to complete Student Resource Sheet 2 together with the class. Remember to allow time for these same students to update their Student Resource Sheet 1 for their compiled portfolio.

- Discuss with students the differences between an angle and a triangle. Help students develop an understanding that an angle, because of the attributes of rays, goes on forever. Because a triangle is a closed plane made up of line segments, it is a **polygon**. (Refer to the New Word list chart).
- Distribute Student Resource Sheet 2. Using a metric ruler, protractor, transparency of Student Resource Sheet 2, and an overhead projector, model how to measure a line segment and an angle. Students will pattern measurement techniques and measure the remaining line segments, angles, and the three angles in each triangle using a ruler and protractor with centimeter units and record their measurements. Demonstrate for students what a centimeter unit is and how to use it when measuring.

- Introduce the new geometric terms for types of angles: **right, acute,** and **obtuse.** Have students label the types of angles they have measured based on the new terms you have introduced. (Refer to the New Word list chart).
- Introduce the new geometric terms for types of triangles: right, acute, and obtuse. Have students label the types of angles they have measured in the triangles based on the new geometric terms. (Refer to the New Word list chart).
- Lead students to discover that a **right triangle** has one right (or 90 degree) angle; an **acute triangle** is a triangle with all angles less than 90 degrees, and an **obtuse triangle** has one angle greater than 90 degrees. Have students label the types of triangles they have measured based on the new terms you have introduced. Encourage students within their groups to explore further aspects of angles, triangles, and polygons and discuss their observations. Their discussion might lead to the total number of degrees that are in all of the triangles that they measured.

Teacher Note:
Students should understand that a polygon is a closed plane with multiple line segments and angles.

Day 2
- Encourage students to share the objects they found in their home environment.
- Reinforce students' prior learning of polygons. Students should work in their groups of 4. Using the 3-foot length of yarn, have students model a quadrilateral polygon. Have the first group to successfully model a quadrilateral demonstrate it for the class and explain how they constructed the geometric shape.
- Discuss (briefly) the attributes of the quadrilateral eliciting the response that it has 4 sides/line segments and 4 angles.
- Distribute Student Resource Sheet 4, a camera, clipboard with writing paper and writing utensil, and a container to each group. Explain instructions for nature walk.
- Proceed onto nature walk with students assembling in their groups of 4.

Teacher Note:
The purpose of the nature walk is for students to make a connection between mathematical concepts learned in the real world. On this nature walk students will gather leaves, branches etc., take photographs, or write notes about objects they see that represent the different geometric shapes that they have been investigating. Students may recognize 3-dimensional figures that are made up of geometric shapes discussed which will lead into the next learning unit. After returning from the walk, students will create a collage or poster and identify the respective geometric shapes.

- Discuss and display completed collages/posters.
- Read the poem from Teacher Resource 3. As you read the poem, have students draw (or perform) each step of the poem on a piece of plain white paper. After they have drawn the square, have students share what they have drawn and assess their understanding of the new terms. Explain what a square is, if it is not clear.

Day 3

- Distribute <u>Student Resource Sheet 7</u>, directions for final project; a piece of white 9 X 12 poster board, and glue.
- Explain directions allowing students time to ask questions. Instruct students to proceed with their geometric design project. Teacher should monitor students to make sure all students are on task and understand the assignment. Provide support when necessary.
- Upon completion of all student resource sheets have students compile into a portfolio with the geometric design as the front cover.

Performance Assessment:

You have completed three tasks showing what you've learned. Now arrange them in sequence and place into the portfolio that your teacher has provided. Write one introductory statement to support or explain your projects. Place this statement at the front of your portfolio. Pass in your portfolio for teacher review. In the introductory statement students must explain what each assignment was and relate it to the geometric concepts reflected in their portfolio. Students must include a learning reflection for each project using the new terminology to describe or explain what they learned during each project.

Teacher will evaluate the portfolios according to the performance rubric displayed on the bulletin board. (<u>Teacher Resource 4</u>).

Extension/Follow-Up:

- Make available plastic baggies with coffee stirrers and pipe cleaners or toothpicks and glue. Provide an instruction sheet for students to construct and mount a variety of geometric shapes identifying their attributes. Instructions should lead students to explore how polygons can be arranged to fit together.

  <u>Home Extension:</u>
- Distribute <u>Student Resource Sheet 3.</u>
  Have students observe their home environment for various representations of lines and line segments, angles, triangles, and other polygons.

  <u>Home Extension:</u>
- Distribute <u>Student Resource Sheet 5.</u>
  Have students cut out three different polygons of their choice to use as templates. Using the templates, students trace the polygons onto different colors of construction paper and cut out as many polygons as they think it will take to cover a 9 X 12 poster board. Students are instructed to put their polygon pieces in the baggie provided and bring it to school for construction of their final project. The teacher will supply polygon pattern, <u>Student Resource Sheet 6</u>, construction paper, and plastic baggie.

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Illustration of the Concept of Points

Have Student 1 and Student 2 stand opposite each other with about 3 feet (36 inches) between them.

Each student should place a sticky dot in front of his or her feet. You may want to alter this to have big dots on their forehead for more visibility.

Discuss that each has marked a point on a plane. They represent two points on the same plane. Identify/label the points A and B.

Illustration of the Concept Straight Path

Have Student 1 walk from point A to point B. You may choose to select another student to walk from his/her seat to another location of the room that is a straight line path.

Through discussion, have the student describe what he/she did to get to the location. Prompt students to use the word straight in their description. You want to elicit the response that the student walked a straight path.

Transition From Angle to Triangle

- Have Student 1 and Student 2, who have changed to be rays during their representation of an angle, give their ends of the yarn to Mr./Ms. Vertex. Mr./Ms. Vertex brings the ends of the yarn together.
- Have Students 1 and 2 grab one point each on the string.
- Each student will now pull out on their respective points to form a triangle.
- Students 1 and 2 still have their point identifications of A and B and need to return to being points (not rays) for the triangle.
- Students 1 and 2 need to be given the same name as Student 3, **VERTEX**.
- Students have now constructed a geometric shape with 3 line segments or sides, 3 angles or vertices, and it is completely closed. Students have now formed a **TRIANGLE** which is a type of **POLYGON**.

Student 3 (Vertex)

C

A   B

Student 1   Student 2
(Vertex)   (Vertex)
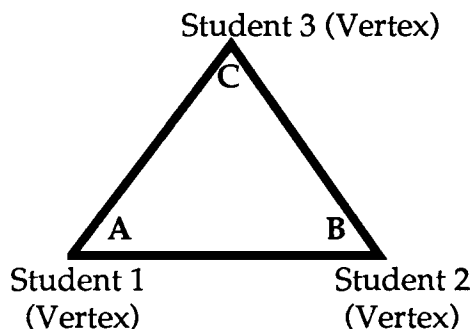
Point, Point, Line - Assorted Shapes, and Designs

Adapted by J. Horner and D. Moorman from the poem
Points, Lines, Shapes and Designs

Begin with two points.
Join them with a line.
Stop! Now make an angle
(You're doing divine).
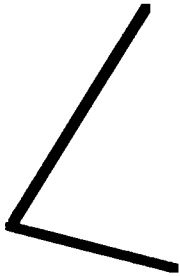
Close the angle
And a triangle will appear.
Slide two triangles together
You've made a square!
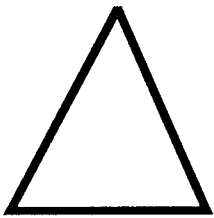
Yes, squares and triangles
With points and lines
Are what we put together
To make shapes and designs!
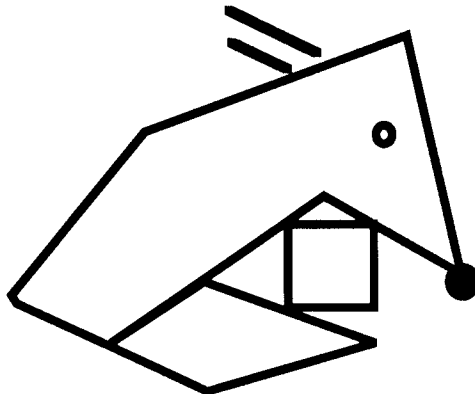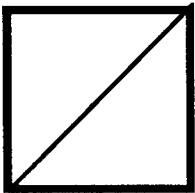
Performance Rubric

Did the student demonstrate the ability to:

- complete all assigned tasks?
- identify, illustrate, and label all shapes used or introduced?
- measure angles and record answers?
- communicate findings mathematically?
- locate, identify, photograph, illustrate, or collect a variety of representations of geometric shapes or patterns?
- construct a design/display using cut-out patterns according to specifications?
- explain and/or communicate what each assignment was?
- explain what they learned in each activity and use the new terminology?

Scoring
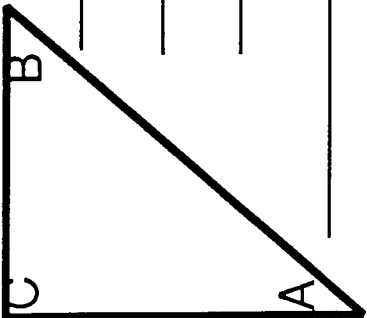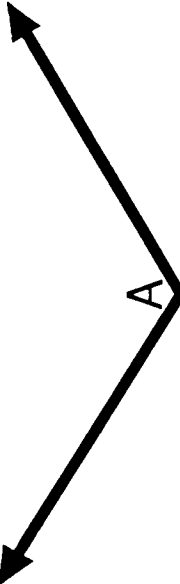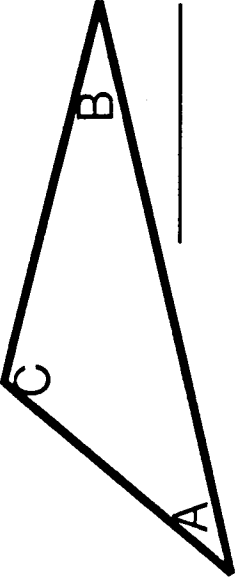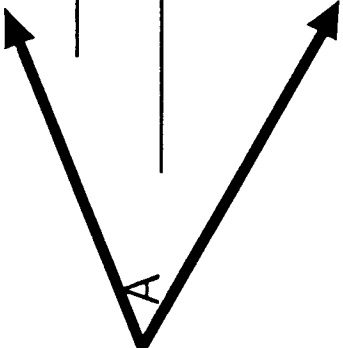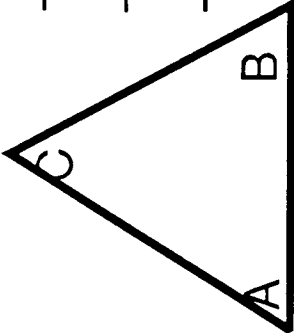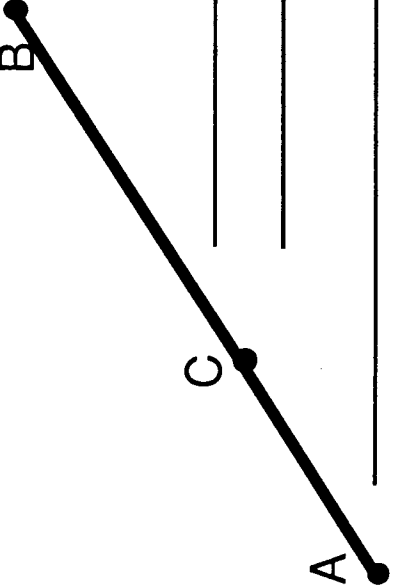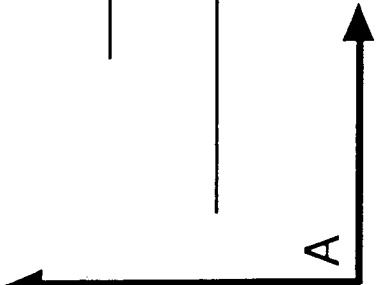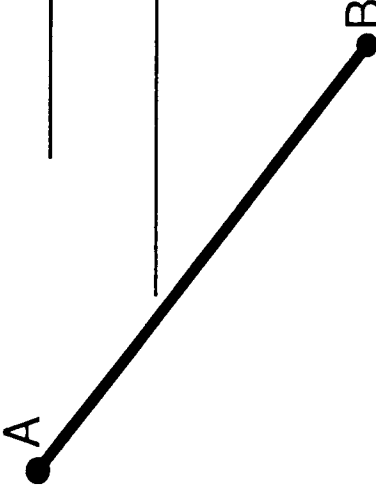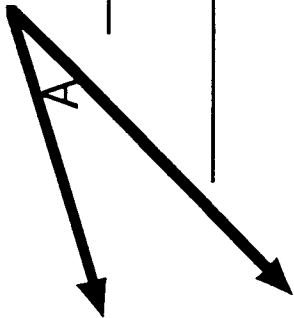
4 - all tasks were completed according to specifications

3 - at least 3 tasks were completed according to specifications

2 - at least 2 tasks were completed according to specifications

1 - tasks were attempted but not completed according to specifications

0 - no tasks were attempted

After each geometric shape is modeled and defined, complete the chart below with an illustration and definition for each new geometric term.

New Terms	Illustration	Definition
line segment		
interior point		
angle		
vertex		
ray		
triangle		
polygon		
right angle		
acute angle		
obtuse angle		
right triangle		
acute triangle		
obtuse triangle		

Student Resource Sheet 2

Directions: Look at each geometric shape. Measure and record the number of degrees in each angle. Measure and record the length of each line segment. Use the centimeter measurements of your ruler and/or protractor.

Home Extension Assignment

Remember, we are surrounded by geometric shapes and designs. You must go home and become a "geometric detective". As you leisurely stroll through your home, look for representations of points, lines, line segments, triangles, and other polygons. You may illustrate and label, or describe each representation below. Use a separate sheet if necessary.
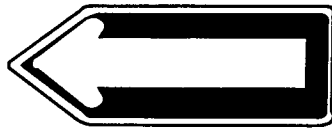
Nature Walk

Today we will stroll around the school and/or park area. Let's look for **lines, line segments, rays, and polygons**. Keep the camera ready! As you spot a geometric shape or design, take a picture, illustrate it, or pluck it and bring it back with you to class. Be sure to gather enough objects for each group member to make their own collage or poster.
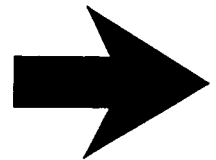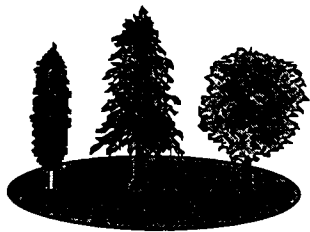
Back in the classroom each of you will make a collage or poster display using the objects and photographs you have gathered. You must select at least one representation of all shapes investigated. Try to find as many different polygons as you can. Don't limit yourselves to triangles.
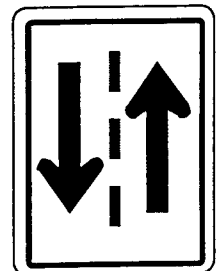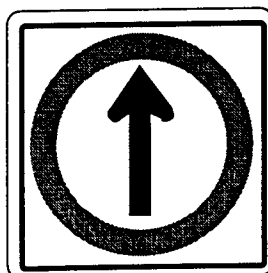
Home Extension Assignment

Look at Student Resource Sheet 6. It contains several different geometric shapes called polygons. Cut out at least 3 polygons of your choice. Use these polygons as patterns to cut out as many as you think will be necessary to completely cover a 9 X 12 piece of poster board.

Trace and cut the polygons on the different colors of construction paper that you have been given. You may practice arranging your shapes on any 9 X 12 surface. Get an adult to help.

Place all of your polygon shapes in the plastic baggie given to you by your teacher.

Bring them to school tomorrow so that you can complete your final project at school.

Your final project is to create a geometric design that will completely cover a 9 X 12 piece of poster board using the polygons of different shapes and colors that you prepared at home.

BE CREATIVE

and
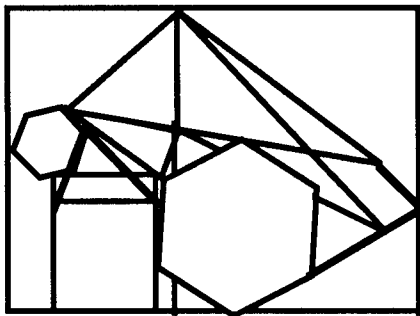
HAVE FUN!

Cut out at least 3 polygons of your choice. You may select as many as you like. See Student Resource Sheet 5 for further instructions. You may want to create your own.
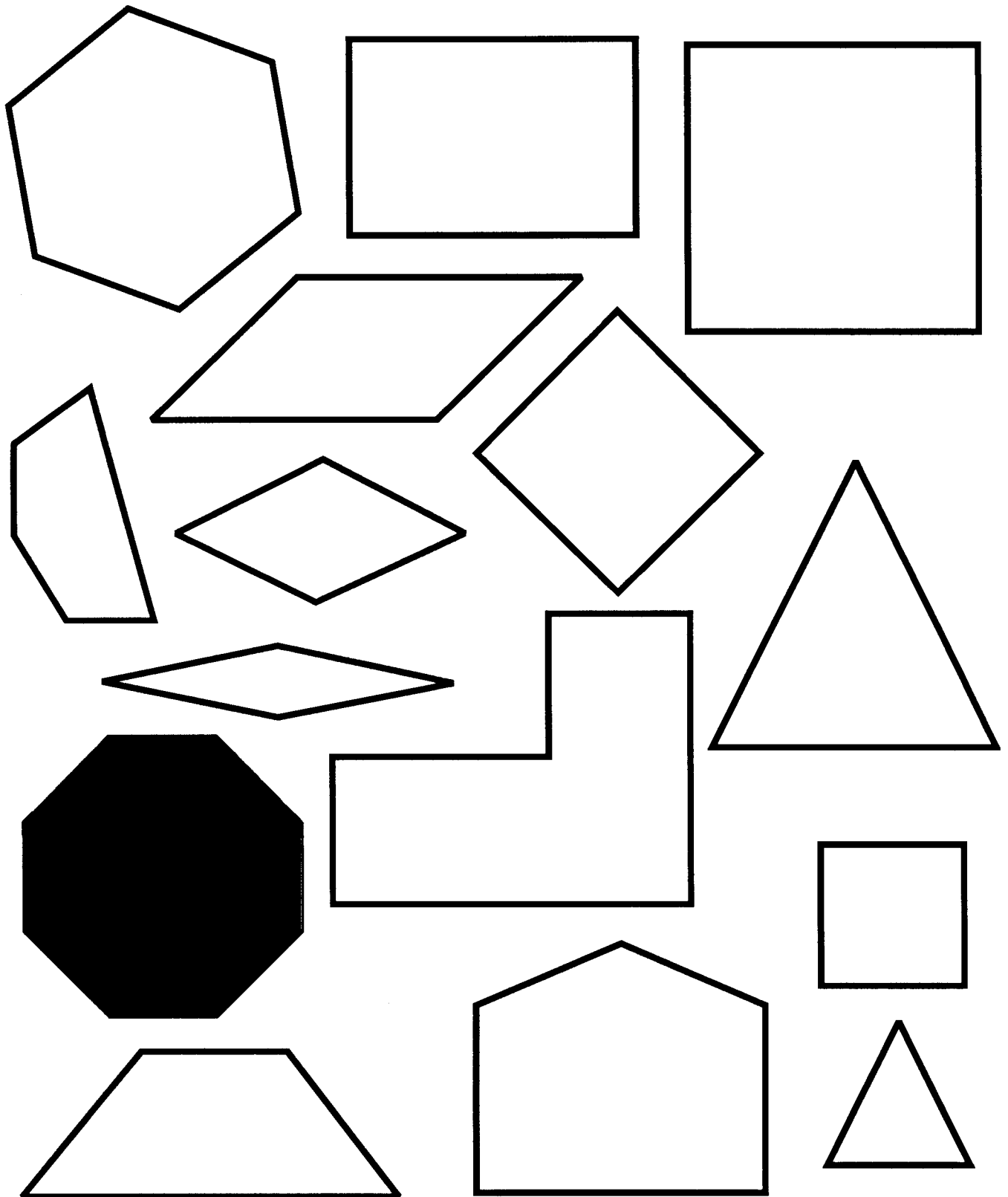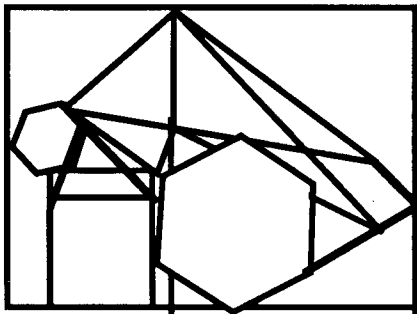
Final Project Assignment

It's time to really be CREATIVE. This is your final project for this unit. You will need your bag of polygons, a 9 X 12-inch sheet of white poster board, and glue. Think about it and plan.

Design your poster with the polygons of different shapes and colors so that it is completely covered with no white space showing. You may want to give your geometric creation a title.

Think about the poem, *Point, Point, Line - Assorted Shapes, and Designs* that your teacher read to you. If you need to see the poem again ask your teacher.

Create your own original poem about your geometric design. Write at least 5 lines. Edit and proofread your poem. Attach it to your poster. Give your completed project to your teacher.

You may find that you did not bring enough polygons to cover your 9 X 12-inch surface. Ask your teacher for a scissors and construction paper and cut out the additional polygons needed.

BE CREATIVE
and
HAVE FUN!